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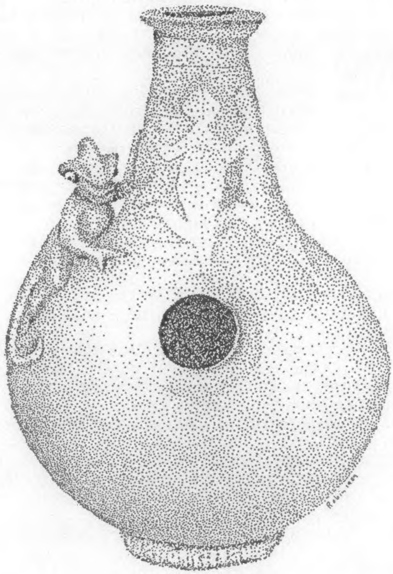
FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS



SUPERBALLS & STRINGS & THINGS

The ceramic vessel pictured at right is a side hole pot drum, half idiophone and half aerophone, made by Frank Giorgini following Nigerian tradition. On page seven of this issue you'll find Frank's description of the making of the instrument. Also herein we have the second half of our study of musical strings. There is as well an homage to the marvelous superball mallet, a report on a classroom instrument making project, and a review of a recent gallery exhibit of new and traditional instruments. We begin, starting below on this page, with musical strings.

IN THIS ISSUE

Above right: Frank Giorgini's UDU drum -- see the article beginning on page 7. Stipple drawing by Robin Goodfellow.

MUSICAL STRINGS PART 2

By Bart Hopkin

This is the second half of a two part article on the characteristics, uses and manufacture of musical strings in all their diversity. The first part, which appeared in EMI's last issue, focussed on the physical properties of strings in general, considering the practical effects of various innate factors on vibrating behavior. In this second installment we will move from the general to the specific, to look at a broad assortment of different string types, their musical characteristics and applications.

The number of basic materials that can serve for musical strings is limitless, ranging from dental floss to massive electrical power cables that sing in the open wind. I have been told by arachnid acquaintances that nothing is more harmonious than a perfectly proportioned web, although my own ears are too coarse to hear. In the following pages we will limit ourselves to stringing materials that are known to have

(continued on page 14)

LETTERS

WELL, HERE I FIND two copies of EMI. #3 and #4. It is always an enormous pleasure to read your magazine and I wonder more and more how you can assemble so much material in two months!

Among the very interesting articles I read, I am most interested by: **Corrugated Tubes**. Frank Crawford [author of the article on corrugated tube instruments in EMI Vol. V #3] must be a very interesting man. I like his style and his way of thinking.

The problem he has with getting the fundamental with a long tube has been studied by Rayleigh and Bouasse for organ pipes. To get the fundamental you need a certain proportion between the length and the diameter. This can be tested with a whistle associated to a hose. Father Mersenne [the 16th century writer on musical acoustics] gives the rule ... in Latin, which is of little help. Years ago when I studied corrugated tubes, I started not from the dynamics of fluids (Reynold's number) but from bird calls: two parallel washers at both ends of a short tube. I would assimilate a corrugated tube to a pile of bird calls.

It is too complicated to discuss the matter in a letter. The puzzling thing is the connection between the small air turmoils (studied by Lootens in the 20s) and the standing wave.

If I had pupils, I would suggest two experiments:

A) Put at the end of the tube a small copy of static aspirators like the ones fixed at the top of a ventilation chimney. It might increase the air current.

B) Take about 100 empty conical yogurt plastic pots with a hole at the bottom. If one makes a pile of these pots, one will get a pile of bird-calls, or a corrugated tube. How will this serpent sound in the wind?

Once more: congratulations to F. Crawford.

Francois Baschet

ABOUT FIFTEEN YEARS AGO I built a "monochord" with with four strings because I wanted to hear the pitches of the natural harmonics in an easily controlled instrument (pre-synth days!). I wanted the fundamental pitch to be C2 (65.4 Hz) because treatises on acoustics use this pitch for harmonics. This is probably because physicists did their experimenting with organ pipes and this pitch is the lowest on an organ manual. To find the length the wires should be, I started by taking a one foot length (between bridges) of some #3 wire, which I'd chosen because it was fairly fine. I tightened this one foot length, while plucking it to ascertain its pitch, until it broke. Then I chose the note one step lower and figured how long that wire at that tension should be to vibrate at C2, the answer being just a shade less than thirteen feet.

I then built a pleasantly shaped instrument, vaguely reminiscent of the medieval Tromba Marina, about 13' 8" long. The tuning pegs were made of 20d nails which I hammered flat on one end & then hacksawed a slot in the flat part to hold the wire. Each nail was long enough to make two pegs. I wanted four strings so that I could play chords.

The biggest trouble (unforeseen, like all major problems) was in handling the wire, which kept kinking and snarling up and breaking. I put the tuning pegs in at a slight slant, thinking they'd resist the pull better that way, for some reason. This slant made the wire, as it wrapped around, work down into the wood that the peg was embedded in, and this caused it to break more readily.

The reason for the very long, thin wire was

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98

that, as you know, only an infinitely long, flexible wire will sound true harmonics. To approach this ideal as closely as possible I used thin, long, tight wires.

When I had gotten one wire on and up to pitch I marked a white painted surface under it according to the number of the harmonic that sounded when the wire was lightly touched there while being plucked or bowed near one end. I did this up to the 32nd harmonic, just about the limit.

I found an interesting effect in the longitudinal vibrations excited by rubbing the wires lengthwise. This tone is between Eb5 and E5 (622-659 Hz) and is loudest when the wires are rubbed near the middle. The pitch to length ratio is the same as sideways vibrating wires but the effect of changing tension is not.

I usually play the instrument with a bow, which is better for the higher pitches.

Robin Frost

From the editor: Robin Frost's empirical observations are correct -- frequencies of longitudinal vibrations in strings are not dependent on tension. The only role tension plays in longitudinally vibrating strings is to hold the string rigid for playing purposes. As far as the longitudinal vibration is concerned, a wire is not much different from a rigid metal rod (which, of course requires no tension). But frequency does vary with length in such situations: doubling the string length will halve the frequency, just as it does with transverse vibrations, because doubling the length doubles the time it takes a wave of compression to travel the length of the string.

I WAS DELIGHTED TO SEE, among other recent articles in EMI, a very substantial one by Frank Crawford on the Corrugahorn. I came across a brief reference to it some years ago, but didn't have enough information on it to describe it in **The New Grove Dictionary of Musical Instruments** [for which letter writer Hugh Davies wrote most of the entries on 20th century instruments -- ed.]. Particularly interesting is the precise physical description of how sound is produced in corrugated tubes. A few weeks ago, by coincidence, I bought an unnamed cheap plastic toy which fits the definition of a Corrugahorn; it is 24 cm long and 1 cm in diameter, with the pitch of the corrugations about 2.5 per cm. Like the whirlies it is reversible. The fundamental is weak, and only the next six partials can be produced, the seventh overtone needing considerable effort. I am also about to realise a very old project, planned and fully worked out in 1971, of a stationary bicycle with fitted multi-color "umbrella;" this consists of several whirlies, all tuned slightly differently, that are rotated by pedal power.

More technical explanations of the physics involved in less common sound-producing principles would be very welcome [in EMI]. Here's one: what I call the principle of the nail violin, which is a rod that is fixed at one end and free at the other, and can be bowed, struck, plucked or (when amplified) blown on; see my additions to the Nail Violin entry in "Instruments Grove." The only mention I have found is in Curt Sachs' **Handbuch der Musikinstrumentenkunde** (1929), where, under bowed idiophones, he writes that a rod fixed in such a way will sound virtually one octave lower than if the rod is suspended or fixed at both ends, similar to the difference between a stopped and an open organ pipe. In particular I am wondering if this also happens with a gramophone needle or stylus, since a record player seems to be a form of 'programmable' nail violin. Can anyone out there help?

I just came across a couple of Polaroids sent to me by a colleague a couple of years ago. These show a small instrument that was slightly damaged when he bought it, called both Solaphone (on the box) and Chellaphone (on the instrument); the manufacturer appears to be called Vocalin. They have the same US patent number, 1284280, placing it around 1918-19. The instrument is only 11 cm long and is square in cross-section (18 x 19 mm); it consists of a rectangular wooden box with a tapered mouthpiece (as with the recorder). Above its upper face a strip of rubber is mounted, concavely arched upwards in an inverted V-shape about 1/3-way along the body of the instrument, and clamped at both ends. The mouthpiece channels the air like a crumhorn into a small wind chest, completed by an interior transverse wall about 1/3-way down the instrument, from which the air can only exit via a small off-center hole in the wooden top. Between the rubber strip and the wooden top is a thinner strip of rubber (now perished), which must function like a reed; it covers the whole top face of the instrument right down to the far end -- where a small metal bell protrudes -- while the thicker rubber strip stops 1.5 cm from the end. The box lid shows graphically that the instrument is played by pressing down on the outer rubber strip with the fingers, the inverted V-shape between the 1st and 2nd fingers (possibly only to improve the player's grip). This instrument appears to resemble Bart Hopkin's Bentwood Chalumeau (EMI Vol. IV #2), and also a somewhat similar instrument described in a 1930 British patent by S.B. Barnes, which I looked at recently, in which a curved spring strip is pressed down onto a rubber one. It is not completely clear from the Polaroids and two telephone conversations (I haven't been able to inspect the instrument in person) how the fingering affects the pitch, unless damping the large area of the reed in different places by the fingers causes it to vibrate at different pitches. It seems that the bell and the adjoining larger interior hollow section may not contribute to sound production.

Hugh Davies

From the editor: In the second paragraph of the letter above, Hugh Davies raises the question of the relationships between the natural vibrating frequencies of a given rigid rod or bar in various

mounting configurations. To get a handle on this question we turn to Donald Hall, professor of musical acoustics and author of one of the leading textbooks on the subject. In response to the Davies letter, he writes:

For uniform bars in general, the reference to "suspended or fixed" leaves a little ambiguity. There are really three distinct mounting concepts (which are more or less approximated in practice). One is an end completely free to move, one might say "floated," as is allowed by the usual xylophone suspension. Another is "clamped," and the third is "hinged" so it can freely swivel even though not leaving the support point. Calling the fundamental frequency f_1, all possible combinations for two ends of a bar of length L would be:

clamp-float	Nail or tuning fork prong; as a standard for comparison we will call its fundamental frequency $f_1 = K/L^2$
float-float	Xylophone; $f_1 = 6.4\ K/L^2$
hinge-hinge	Lower fundamental: $f_1 = 2.3\ K/L^2$
clamp-clamp	Perhaps surprisingly, also $f_1 = 6.4\ K/L^2$
clamp-hinge	I suppose a factor between 2.3 and 6.4
hinge-float	Incapable of vibration; $f_1 = 0$

All information about material and thickness of bar is in K and remains the same for all cases. The closest we can come to a factor of 2 for an octave [as Davies reports Sachs suggested] is well-oiled hinges; 2.27 would be about two semitones extra. In conclusion, I don't think we had better take Sachs as precisely authoritative on this; I suspect he might have used "virtually" rather loosely, or picked up and misinterpreted some fragment of theory. Or, more charitably, maybe he had some case where some less idealized way of mounting (which we are not understanding from his description) really gave something close to an octave change.

Donald Hall

Hugh Davies also raises the question of whether the frequency-determining factors for a nail violin (rod fixed at one end) come into play in a phonograph stylus -- which, being a vibrating body somewhat similarly shaped and mounted, seems to present a reasonable analogy. To put that analogy in context, though, we should observe that a phono stylus must be specifically designed NOT to manifest resonant frequencies of its own (at least not in the audible range), so that it can respond to the record groove in an unbiased fashion. Thus, to the extent that a stylus actually behaves like a rod on a nail violin, it's a poor needle and cartridge. That said, seeing the stylus as a 'programmable nail violin' -- one which responds not to its own inclinations, but to the dictates of an outside controller -- seems fair enough.

FOLLOWUPS / MISCELLANY / NOTES FROM RECENT CORRESPONDENCE

Some time back EMI passed along to Ivor Darreg a reader's inquiry about the availability of theremins. In addition to responding to that reader, Ivor sent a note back to EMI. We reprint it here, since others, no doubt, will be interested:

There was an outfit in Texas or nearby that sold kits for building a theremin. I haven't heard of them for several years, so I will have to check out who if anybody makes kits now. If I can't find such a firm anymore, I can send a xerox of an old how-to-build magazine article that is in a box somewhere around this house.

What makes this inquiry and others like it important is that with all the commercial instruments, mostly with keyboards, cloning each other -- synthesizers, samplers, and toy versions of each -- I don't want to see certain earlier concepts forgotten. Besides the theremin, there are other melodic instruments that have new timbres but are not suitable for mass production because they can't be pretuned and pre-adjusted at the factory -- they need attention from the performer much like that a violinist or bassoonist or saxophonist must be willing to give. The mass market wants Instant Magic Right Out of the Box, or TV dinners instead of Roast Your Own and Make Biscuits from Scratch.

These forgotten electronic instruments however, and the theremin itself, can still be built out of standard electronic parts. The home builder can be quite individualistic about them. And they don't cost too much either. The cost would be in time -- finding the circuits and doing some designing and tweaking while building.

The result would be something not identical to all the sounds heard at the nearby shopping mall, but your own voice, not theirs. Electronic does not necessarily mean mass-produced Clones.

Time to get off the soapbox and over to the mailbox.

Ivor Darreg
3612 Polk Ave.
San Diego, CA 92104

MORE BULLROARERS: Charles Adams has sent along one more note on whirled instruments (the topic of a recently concluded series in these pages), in the form of the following passage from Figura, translated in Alfred C. Haddon's **The Study of Man**, chapter X, "The Bull-Roarer" (London: Bliss, Sands & Co., 1898; pp. 277-327).

Wheels of Fortune

A "favorite [card] game of the French gaming clubs owes its name [**bezique**, similar to pinochle)] to the bull-roarer" (Figura 1896:226, translated in Haddon 1898:287). More specifically, this author explains, people in rural Galicia (a region in southwestern Poland and western USSR) often employed the instrument for driving cattle home from pasture in the evening. "At the beginning of the revolutions the bull-roarer produces a note corresponding to the letter b-----s (greatly protracted). By swinging some time and more quickly the high note passes into a low organ note. This tuning effect is called in Galicia, among both Poles and Ruthenians, **bzik**. The wooden object itself has no name. This buzzing or humming noise excites pasturing cattle. As soon as the bull-roarers are started the calves stretch out their tails into the air, and kick out their hind legs, sometimes to the right, sometimes to the left, as if they were dancing. After some minutes the old cattle follow the young ones and there is the general stampede in the village. Therefore one says in Galicia that a man whose brain is not quite right has a "bzik." It is supposed that the animals get into an idiotic condition owing to the buzzing of the bull-roarer ... It is well known that in the year 1831 thousands of young Poles emigrated to foreign parts, especially to France, and there a great number enlisted in the Algerian foreign legion. The Poles used to play cards and their game was called **bzik**. The Frenchmen got to like the game; and they could pronounce the word, but in writing it down in French orthography in became **bezique!**"

Bob Phillips, whose Bellow Melodica appeared in EMI's last issue, writes

I was happy to see the article on the Bellow Melodica fit in so well with the rest of the issue.

Since developing the device I've come up with a close cousin to it. Namely, the Orgone Box; an acoustic synthesizer.

It is a more expressive instrument compared to the B.M. because it possesses a greater dynamic range, a larger compass ($3\frac{1}{2}$ vs. 2 1/3 octaves) and a more flexible timbral potential.

It consists of the "piano" section of a smallish, Italian-made, 30-year-old accordion (it's red flake with red sparkle "black keys") (cool) and, a foot operated Ambu-bag that delivers air into a respirator "test-lung" (like in B-grade or made-for-TV hospital flicks) that acts as a wind reservoir for the reeds.

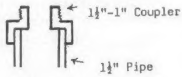
The whole thing sets on/around a Manhasset music stand that works very well for adjusting from sitting to standing positions, etc.

Bob Phillips

Notes from Tony Pizzo on recent activities and where to get what:

... RIGHT NOW, I'M HOPING to get into a slightly more active instrument building mode and work on plans for a super stripped down but usable make it yourself PVC tambura.

Also, trying to drone my way to bliss with a 5' length of $1\frac{1}{2}$" PVC didjeridu.* If anyone asks, you can make an excellent mouthpiece by attaching a $1\frac{1}{2}$" to 1" coupler at one end. They're threaded on the 1" side and smooth on the $1\frac{1}{2}$" side.



Lark in the Morning (Box 1176, Mendocino, CA 95460) has a decent didjeridu instruction tape for sale. It doesn't cover the circular breathing end of it (Robert Dick's "Circular Breathing for the Flutist" can do that -- I think Lark sells that as well) but it's very helpful for getting started on the lip buzz technique.

Tony Pizzo

* Remember that Poly Vinyl Chloride is toxic. Other plastics may be preferable in cases where there will be oral contact.

EMI IS NOT EMI

EMI happens to have the same initials as EMI, the European recording industry giant. A couple of times here at this EMI we have received mis-addressed demo tapes from aspiring musicians, intended for the other EMI. The conscientious thing to do in this situation would be to return the tapes in virgin condition to the sender with a note explaining that this EMI is not that EMI. But what I have actually done is <listen first> and THEN return the tapes. I get a slightly voyeuristic feeling doing this (secretly listening to music that wasn't intended for me).

Both of the tapes that have come this way were heavy metal. I make that categorization with confidence, since both were addressed to "A&R, Heavy Metal Dept." I liked one of the tapes quite a bit. It was mostly a sort of small sounding distorted electric guitar accompanied by a rhythm box, with rough, half-shouted vocals, generated by someone who signed himself "Rick Rebel." An accompanying photograph showed a resentful-looking young man in torn jeans and a shirt which revealed his navel. The songs, despite the harshness of the vocal and instrumental timbres throughout, were all love songs.

It always seems like there's so much music around, with so many hungry egos attached. At times like this I'm completely unable to say that any music is any better than any other music. So I say, good luck to you, Rick Rebel. It's likely you got a better listen from me that you will from the other EMI.

Bart Hopkin

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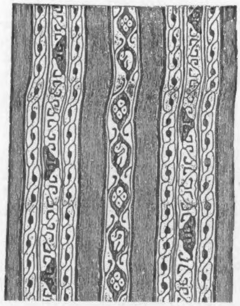

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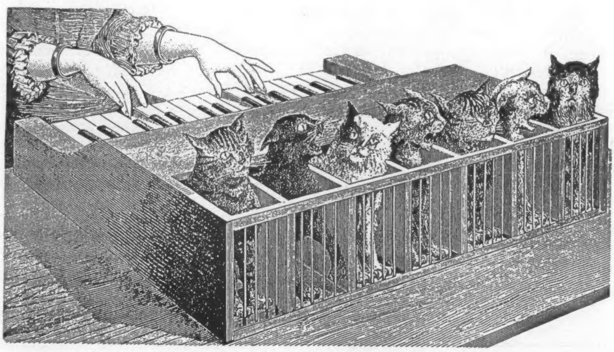
DOES ANYONE KNOW the source of the drawing reproduced below? It turned up a few years back in a collection of public domain graphics, and has appeared subsequently, as a result, in a smattering of other places. (Public domain graphics are illustrations for which no one holds proprietary rights, and which can therefore be reproduced freely by anyone wishing to do so.) No background information appeared with the drawing in the public domain collection.



102

UDU DRUM
Voice of the Ancestors

By Frank Giorgini

Frank Giorgini's UDU DRUM is a clay pot drum modeled after the Nigerian side hole pot drum. It is made entirely of clay, in the form of a narrow-necked, vase-like vessel, with a circular hole in the side in addition to the opening at the top. Playing technique for the traditional drum varies considerably from one region to another and one player to another, but basic technique incorporates drumming on the side hole while selectively opening and closing the top hole to modulate the air chamber resonance with the other hand. Thus, the drum is part idiophone and part percussion aerophone, and, it should be noted, no part membranophone. The sound is one of deep air resonance articulated by quick, bright percussion, at times light and bubbly and at times profound. Bent tones resulting from the player's modulation of the apertures can be reminiscent of tablas or talking drums.

In the following article Frank Giorgini describes both the "formidable ancestry" (Frank's words) of his instrument, and his own developments, based in the African tradition but taking an exploratory approach.

In the summer of 1974, I had the opportunity to live and work with a group of African artists at the Haystacks Mt. School of Arts and Crafts in Deer Isle, Maine. As a result of this unique cultural exchange, I learned the little known art of making the all clay side hole pot drum. The origins of this drum can be traced to central and southern Nigeria. It is the invention of some ancient village potter who struck a second opening in the side of a traditional clay water vessel and discovered the resonating sound it produced. The man who first introduced me to the side hole drum is Abbas Ahuwan, a Kaje potter, artist, and professor at Ahmadu Bello University, Zaria, Nigeria. From the teachings of Abbas at Haystacks, I learned the traditional Nigerian pottery techniques that are employed to create the clay drum.

I call my drums UDU DRUMS, but the side hole pot drum has many different names in Nigeria, depending on tribal areas and ceremonies in which it is used. "Abang mbre" or "pot for playing" is the name generally ascribed to it. Some believe the deep haunting sound particular to the drum is the "voice of the ancestors," and it is used in many religious ceremonies.

I form each UDU DRUM true to the traditional techniques that were handed down to me from Abbas Ahuwan. Moreover, I have developed many design innovations, clay body formulas, and firing tech-

FIGURE 1: Full set of 4 UDU DRUMS.

niques that have improved the sound quality, durability, and versatility of this instrument. I make the basic drums in a set of four, corresponding to the traditional African family concept of drums (FIG 1). They range in size from 18 cm to 40 cm in height, the smallest having the highest pitch and the largest the deepest pitch.

The first step in the traditional method of creating the drums is to pound a lump of soft earthen clay over a hard round form (hump mold) with a flat stone. The clay is carefully pounded and paddled with handmade wooden paddles until a uniform thickness is attained. Then it is trimmed to a half sphere on the hump mold. The size of the mold determines the size of the drum, because the half sphere is removed from the mold and becomes the bottom half of the drum. The rest of the drum is made by the coil method, which involves attaching individual lengths of clay one by one, squeezing, paddling, and scraping them into shape as the sides are worked up. It is very important to maintain a uniform thickness in shaping and smoothing the contours and compound curves that make up the transition from the round body of the drum to its neck. I usually work on three or four drums at a time, building up the sides at a rate of only about one and one half inches per day. After about ten to fourteen days the drum is formed and I cut the side hole. The entire drum is then burnished (hand rubbed) with a smooth stone. This process seals the surface of the drum and gives it a deep luster without using glazes which deaden the sound. The drum is now allowed to dry slowly under controlled conditions. When completely dry, the drum is fired to a specific temperature for hardness and sound quality. It is fired a second time in an outdoor kiln, removed from the flames when glowing hot, and plunged into a container of combustible material. When removed from the smoke and ashes of the container, it has its traditional deep black luster. The whole process of forming, drying, and firing a drum takes about one month.

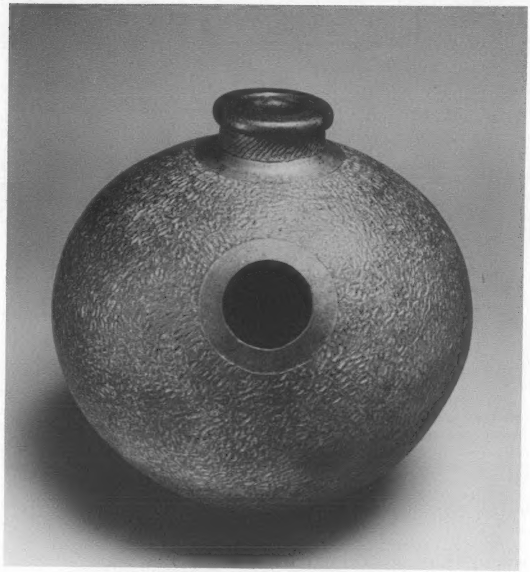


FIGURE 2: One of Frank Giorgini's early drums

Traditional Nigerian Side Hole Drums

An interesting phenomenon results from forming the drum with these ancient, traditional pottery methods. Clay is composed of some of the smallest physical particles that make up the earth's surface. These clay particles are shaped like flat disks or plates and are randomly packed together with moisture to form soft workable clay. The continuous pounding and paddling of the clay during the forming process compresses, aligns, and interlocks these microscopic platelets into a strong, dense body. It is much the same in principle to the hand hammering of brass cymbals for tonal quality. So, as is often the case,

another "primitive" process proves, in scientific analysis, to be a superior technique.

I have spent many years experimenting, developing, and fine tuning my UDU DRUMS. I have researched the composition of the clay native to Nigeria, and adapted it to a combination of natural clays available in the U.S.A. Through extensive experimentation, I arrived at a firing temperature that yields a much stronger drum body, yet retains the deep tonal qualities associated with the very low fired, open bodies of the African pottery drums. In the fifteen years that I have been making this instrument, not one has ever cracked under a player's hand, a very common problem with its African counterparts. My traditional hand building technique has been refined to the point where I am able to maintain a consistent .8 cm thickness throughout the entire body of the drum. This greatly enhances its resonating qualities.

The greatest innovative development to the original instrument's design has been my modification of length and shape of the neck. The traditional central Nigerian drum that I first learned to make was completely round with a short neck (FIG 2). In 1985, on a research trip to Nigeria, I encountered a drum with a long tapered neck and a flared, wide top opening, seemingly more typical of the southern areas. This design projected more sound, but I felt there was a loss of efficiency due to the wide taper and opening. About this time I became aware of Hermann von Helmholtz' work with air chamber resonators. The acoustic system he described and mathematically analyzed consists of a single hollow sphere with a straight neck of calculated length and width relative to the volume of the chamber (FIG 3).[1] Again, the acoustic system described in the modern academic analysis is precisely analogous to that of the ancient clay pot drum.

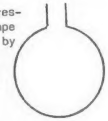


FIGURE 3: Standard resonator shape described by Helmholz

I combined elements from each of these sources and arrived at what I believe to be an instrument of greater volume, resonance, and controlled tonal qualities. I redesigned the lip around the neck opening to provide a more comfortable flat playing surface. The combination of a wider neck base, a consistently thin body and a new firing temperature resulted in an improved high pitched playing area around the side hole. Tabla players responded with great interest because this new design could mimic the sound of the tabla drum, both high and low pitches, and intricate Indian finger techniques could easily be adapted to the UDU DRUM. Since an all clay drum has no temperamental skin to continually adjust, the sound will remain consistent regardless of changes in humidity.

(continued overleaf)

1. Helmholtz' analysis for resonators of this specific shape has been useful in understanding a wide variety of air resonating systems having a non-tubular air chamber communicating with the outside air through a single aperture. The term "Helmholtz resonator" has come to be applied generally to air resonator shapes that meet this description and behave as Helmholtz predicted.

FIGURE 4: Kim Kim drums made by Frank Giogini

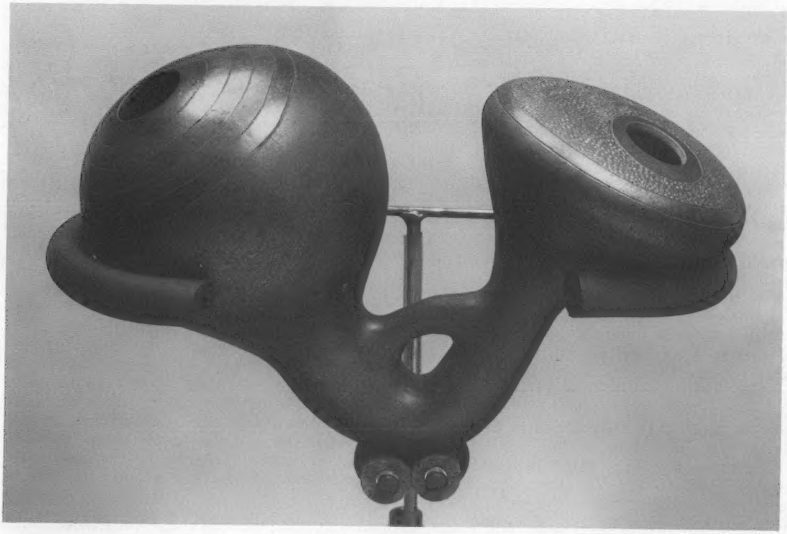


FIGURE 5:
Hadgini Design

NEW SHAPES / NEW SOUNDS

During my research trip to Nigeria in 1985, I encountered a double chambered clay drum known locally as the Kim Kim (FIG 4). It was a vertical dumbbell shaped form with a hole at the top and the bottom. The player held the narrow middle section in one hand, and rhythmically raised and lowered the drum off her thigh while striking on the top hole with the other hand. Two distinct tones resulted from the bottom hole being covered or uncovered by the player's thigh. I recorded the Kim Kim, along with several side hole clay drums and a very large clay drum played with a leather paddle. These clay drums, plus a shekere and a wood block, provided the orchestral accompaniment to the Women's Wing Choir of the Evangelical Churches of West Africa.

Upon returning to the USA, I started making the Kim Kim drum and experimenting with its form. I made them larger and larger until they were too heavy to be played in the traditional manner. This resulted in my devising a horizontal playing technique using one hand over each hole, yielding four pitches by various combinations of striking and covering or uncovering the other hole. I also modified the shape of the two chambers. I made the left side large and round for the deep pitches and the right side flatter and wider for high pitches and greater finger striking area. In order for the drum to sit more comfortably in the player's lap the tubular middle section needed to be curved in a U shape. This would also bring both playing surfaces up to the top and next to each other like a bongo drum.

Around this time Jamey Haddad, a percussionist very skilled in North and South Indian hand drumming techniques, approached me with his concept of a double chambered electrically amplified clay drum. This coincided with my own design development of the Kim Kim, and our combined input resulted in a dynamic new instrument. The drum is basically a large curved Kim Kim with the flatter right playing surface modified. By offsetting the hole to one side the finger striking area was relocated to the center and became more responsive. I provided two small holes to accommodate an internal microphone system designed by Jamey to capture the wide variety and previously unheard sounds occurring within the drum. We named this instrument the "Hadgini" in recognition of our mutual contributions (FIG 5).

I have continued to design and experiment with many new shapes of drums, while still making my original UDU DRUMS. I have combined two large chambers of the side hole drum with a very short connecting center section. This drum can be played like a bongo drum with the holes on the top surface. It has a variety of strong, deep pitches with very quick action. I call this instrument the "Udongo" (FIG 6). It can be played acoustically or electronically amplified.

My latest design combines the best features of the side hole drum and the Kim Kim. I started by forming the largest size UDU, but when I reached the upper section of the neck, I flared it out to a wide flat chamber with the hole in the middle of the top surface. I left the side hole in place, instead of on the bottom like the Kim Kim. These innovations enable the drum to be played horizontally or vertically and provide a wide top surface for finger techniques. It combines all the sounds of the previous drums into a very simple and beautiful form. It can also be played acoustically or electronically amplified (Fig 6).

Each of my new designs evolves from the shape

of the drum before it. By playing, handling, listening to, and analyzing each drum, I am able to make improvements and experiment with new forms. It takes about 40 to 50 hours over a period of two months to construct a new design, so I become very intimate with these instruments. My background is in sculpture and design, so I approach these drums first as visual objects. As a student of industrial design, I was taught that "form follows function". This has been very true in my work with the clay drums, and from my experience with them I would add that "sound follows form". The sounds emanating from the hollow clay vessels are so related to their sculptural form, that you can almost visualize the drums' shapes from their auditory vibrations.

NEW DRUMS / NEW TECHNIQUES

All my original UDU DRUMS are still completely hand-made by myself according to traditional Nigerian pottery techniques. The resulting drum is a state of the art instrument and museum quality artifact. They have become the choice of the world's leading percussionists and have been entered into the permanent collection of the Metropolitan Museum of Art. I owe this to the spirit and heritage of this unique instrument.

Because of the time and skill involved, I am only able to create about thirty drums a year. The demand is greater than my hand production allows. After much deliberation, I have decided to make molds of my original forms and produce the drums by non-traditional methods. After several years of research concerning clay body formulas, production methods, and firing temperatures, I have succeeded in producing a line of molded clay drums that are of a quality befitting their formidable ancestry. They will be offered by CLAYTONE PERCUSSION, a separate division of UDU DRUM, and will include all the drums previously described. It will be the goal of UDU/CLAYTONE to produce a high quality instrument, at an accessible price, for a wider audience of percussionists.

I will always make my original UDU DRUMS by hand, using traditional Nigerian pottery techniques as handed down to me by my Nigerian teacher, Abbas Ahuwan. They will continue to be true in spirit and the finest instrument of their type in the world. And now I will be able to offer an affordable alternative.

FIGURE 6: Set of 4 molded drums for Claytone Percussion.

EXPERIMENTAL MUSICIANS: THE NEXT GENERATION

By Joan Epstein

Joan O. Epstein, Associate Professor of Music at Eckerd College, St. Petersburg, Florida, coaches chamber music and teaches courses in Classic Period, 20th Century and American Music. A trumpeter, she performs mostly Baroque and modern repertoire. She also directs the Aurora Contemporary Ensemble.

Exploring new sonic and expressive possibilities.

Discovering the natural connections between musical style and instrumental sound.

Deepening respect and appreciation for music's greatest innovators -- and traditionalists.

These are some of the results when I ask my students at Eckerd College to design completely new musical instruments and write appropriate pieces for them.

I have made this assignment with good results to several groups of new freshmen in a how-to-do college course in American experimental music. At the end of three weeks, I have a classroom crowded with instruments ranging from modified palm fronds to bed frames spangled with Busch cans and egg beaters. Usually, I also have students -- mostly non-musicians -- who champion the likes of Ives and Varese and Partch and who, more importantly, have learned to solve creative problems, to listen, research and discuss, and to be open to and take seriously new ideas.

During the spring of '89, while on sabbatical leave to compose and research, I tried out my assignments with elementary school students at a center for gifted students in Pinellas County, Florida. There I had the most fun -- and best results -- ever. If these kids' creations aren't featured in the pages of **Experimental Musical Instruments** in a few years, I'll bet their inventions will be featured at trade shows and their brilliant insights at meetings of scholarly hotshots.

I asked the students, aged 8 to 10, to bring five objects or materials from home and to inventory these materials' sound possibilities, alone and in combination. Brainstorming with a partner in class allowed most of them to expand their lists of possibilities by two or three times. Then I asked them to design an instrument on which they could produce their most interesting sounds with ease. They were encouraged to create designs which were visually as well as aurally exotic. The finished products had fanciful names like Grade A Large, Basket Case, Windle, and Four Buttoned Bongo. The sounds they produced were as terrific as the monikers.

Kacey Stanton rehearses her composition for her Shake, Rattle & Roll Machine.

LEFT:
David Ross &
Terry DeCola
explore the
musical potential
of The Box.

BELOW:
Ryan Lahre &
Jaclyn Infanzon
with their joint
design, Banracca.

At the next week's session we improvised with their instruments. At first, they performed randomly under a student conductor, just to get a feel for the expressive potential at their command. Then they improvised series of contrasting or gradually modified sounds at varying pacings -- the "stuff" of much abstract composition. Next, after working abstractly, the students improvised music unique to their own instruments which fit terms like "fierce" or "whimpering". The final task for the day, and perhaps the most challenging one, was to devise symbols for their sounds -- symbols which anyone might read or understand.

At our final session, the students composed 2-minute abstract or descriptive pieces. Rough pencil scores were transformed into colorful final scores once the compositions were set. After a short rehearsal with a partner, each student performed for the full group and a for a video camera. The kids had fun performing and listening; they played enthusiastically and applauded each other loudly. But as new and serious (!) composers, they did not hesitate to offer insightful criticism -- to share what they liked most, what they saw as needing improvement and what they thought might work for a marvelous next piece.

On the whole, these few hours of experimental musicmaking -- along with several other experimental art projects -- were a wonderful complement to many more hours of traditional artmaking, concert going, museum touring and research which occupied the lucky youngsters at Pinellas County's Area IV Gifted Center one day a week last school year. I am grateful for the opportunity to work with a new generation of innovators, and with their inspired teachers, Smelia Damjanovich, Sally Hansen and Barbe O'Steen. Look out, EMI! Look out, world!

MUSICAL STRINGS, PART 2

By Bart Hopkin

(continued from page 1)

played an important role in human musical culture. Even with that restriction we will surely be leaving many out.

We'll begin with ...

METALS

Metal wire is made by pulling the material through a series of progressively smaller holes in a specially-made die called a drawplate. With each draw, what might have started as a rod or bar of metal becomes longer and thinner, until it is ultimately pulled through a hole of the desired final wire diameter. In addition to shaping and sizing the metal, this process hardens and strengthens it.

The most important property for a metal to have if it is to be drawn into wire is high ductility. Ductility actually represents two complementary factors -- malleability and tensile strength. The ductile metals that are made into wire are malleable enough to be reshaped during drawing but strong enough not to lose their integrity and break in the process.

According to most sources, wire drawing has been practiced in Europe at least since the 10th century AD. There is speculation that it was practiced much earlier elsewhere -- perhaps as early as several centuries B.C. in Persia. Prior to the invention of the drawing process, wire was made by cold hammering, but it is not known that such wire was used for musical purposes. The earliest wires, both hammered and drawn, appear to have been gold, chosen for its malleability and workability. In the ensuing centuries, iron and then brasses and copper came to be used.

A typical reduction in cross sectional area at each pass through the drawplate for early drawn wire might have been around 11%. This naturally requires great force, especially in the coarser stages. Wire was pulled by hand until sometime late in the 15th century, when water mills were first employed. In the 14th century a wire drawer's guild came into being, its monopoly secured by the strict protection of trade secrets -- a fact which has made life more difficult for latter day scholars interested in early metalwork. Commerce in music wire was highly organized from an early date, and certain manufacturing areas came to be noted for the quality of their wire.

The guild was divided into specialized laborers. Perhaps the most important was the maker of the iron draw plates, who determined the final wire sizes and the percent reduction for each draw. There was no standard of measurement for the hole sizes; no outside reference; there were only master drawplates from which new drawplates could be copied. It appears that there was an international trade in these plates, and so some degree of uniformity of wire diameters existed from one manufacturer to another.

Gauge numbers were used to indicate wire sizes. Unfortunately, unlike the actual sizes, the numbering systems used by different manufacturers were not uniform. This confusing state of affairs lasted for centuries. Around 1870 several national systems were approved which, unfortunately, still were not in agreement with one another. In recent years, with the wider availability of accurate measuring devices, the practice has increasingly been to designate the gauges by their actual measured size. Despite this eminently reasonable solution, ghosts of conflicting numbering systems linger and continue to cause confusion today.

High carbon steel wire began to replace iron between 1810 and 1830, and after the middle of that century the heat treated high tensile steel music wire used today became common.

Modern wire drawing techniques differ little in principle from those that evolved centuries ago. The old draw plates are now replaced by dies of alloy steels, carbides or diamond. Several dies may be lined up in tandem so that the wire can undergo its full reduction in one pull. The wire is pulled through at high speeds (up to thousands of feet per minute). The die's angle of reduction may be 6 to 15 degrees; the percentage reduction of cross section area of the wire may be 10% to two or three times that per pass. Lubricants reduce friction in the passage; they may be applied to the wire surface or the entire operation may take place submerged in lubricant. The greater the total reduction of cross section area between the original rod size and the ultimate wire size, the greater the work hardening of the material, and this is reflected in the hardness terminology for drawn wire: wire which has undergone a 37% total reduction is called **half-hard**; 60% is **hard**. Music wire is usually in the range termed **spring**, at 84% reduction or more.

Metals that have been used for musical strings include high and low carbon steel, iron, various brass and bronze alloys, copper, zinc, tungsten, silver and gold. At one extreme are hard, strong materials of high tensile strength, high elastic modulus (resistance to stretching), high rigidity and low internal damping. These factors generally correspond to a bright sound and a string that is especially effective at high tensions and in the upper registers. At the opposite end of the scale are softer materials, which have a rounder sound and have certain advantages in the lower registers.

The modern favorite for metal strings is high tensile strength, high carbon steel, variously called music wire, piano wire, zither wire, etc. Very hard virgin Swedish steel generally gets the highest recommendation. These steels are widely used on pianos, steel string guitars, mandolins, banjos, and so on. (Overwindings for bass strings may be of other materials.) This wire has the great advantages of being the most durable of available stringing materials, and able to with-

stand the highest tensions. Its internal damping is the lowest. The tone, as a result, is the brightest of available stringing materials. Unwound steel strings that are thick relative to sounding length are more subject to inharmonicity than strings of other materials, due to the rigidity of the material. On the other hand, this is compensated for by the fact that steel strings can be strung at higher tensions than other materials, making tension outweigh rigidity as the primary restoring force in the string's vibratory movement and thus contributing to improved harmonicity.

While steel is used in all applications these days, its special forte is situations calling for fine wire at high tension. For a given string length, the upper limit on range for high tensile steel is about a fourth above the highest possible pitch of its traditional competitor, iron. For lower pitches, such as most of the piano range, thicker steel wire of slightly lower quality and tensile strength is often used. Because of its great strength even at narrow diameters, high tensile steel is also a common core wire material for overwound strings.

Steel is subject to rust. For applications where moisture is a potential problem -- in particular, for outdoor musical installations -- some builders have turned to stainless steel wire.

Iron was a preferred material for metal strings for centuries before steel came to dominate. It remained popular well after the technology for steel wire was available, indicating that it was preferred for its own merits, not merely because of a lack of alternatives. The iron wire used on early instruments was nearly pure, lacking trace elements usually found in modern irons. Iron has lower tensile strength and elastic modulus, and slightly higher internal damping. The tone is rounder and less bright. Harpsichords strung with the traditional iron, as well as brasses, do not have the aggressive, jangly sound of modern harpsichords strung with steel music wire -- think about that next time you find yourself trying to sort through the upper partials in somebody's steel string continuo.

Brasses and copper rank below steel and iron in strength. Brasses are comprised of copper and zinc, sometimes with traces of iron, nickel, lead or other metals. In the early days as now, they could be roughly classified as red, containing about 7% to 15% zinc, or yellow, with zinc content in the 22% to 30% range. Their lower elastic modulus allows them to be used at relatively low tensions with less pitch distortion, yielding an acceptable-sounding lower range limit about a fourth below that of iron for a given string length. For this reason brasses have been used in the lower ranges in harpsichords, with more copper in the alloy for the lowest strings. In their usefulness in the lower ranges, however, they have largely been superceded by overwound strings.

The scale of decreasing tensile strength and rounder sound continues with silver and gold, although in practice for obvious reasons these have only rarely been used. The acceptable-sounding lower range limit for gold is about an octave below that of iron for a given string length.

We turn now to the metals used for overwinding wire. Some slightly different factors come into play here. Tensile strength is less important but hardness remains a consideration, and surface characteristics such as appearance and resistance to rust and tarnishing take on increased significance. Various metals have been used for overwinding, including nickel, brass and bronze, copper, silver-plated copper, phosphor bronze, aluminum, stainless steel, tungsten, monel metal (an alloy of approximately two parts copper to one part nickel), silver and gold.

Strings for instruments using electro-magnetic pickups should be made of sufficiently magnetic metals to induce a strong response in the pickup coil. Steel is good in this respect. For overwinding electric instrument strings, nickel is often used.

GUT

Animal intestine is one of the oldest stringing materials. In fact, legendary archetypal string instruments were explicitly gut-strung in more than one mythology. Gut is certainly one of the finest natural materials for the purpose, being very strong, reasonably supple, and available in great lengths. As testimony to its effectiveness, gut has also traditionally been used for such purposes as tennis racket stringing, surgical stitching, and hunting bows. In recent years gut has been supplanted to a large extent by nylon. It still appears on some non-western instruments, and here and there in western instruments as well, as in some double bass strings or as a core for wound violin strings, as well as replica instruments.

There is a popular, often debunked notion that gut strings are made of catgut. In correcting this myth, the common assertion is that in truth they are normally made from sheep gut, which apparently possesses the desired qualities of strength, length (up to one hundred feet in a single strand), suppleness, and uniformity more than the intestines of other animals. Early as well as contemporary accounts refer to sheep gut in string manufacture. Donna Curry (of Donna Curry's Music, which specializes in gut strings) reports that in Italy during the renaissance people preferred the guts of mountain goats and sheep, the goats in particular having stronger guts. In contrast to all this, Bob Archigian of the string manufacturing firm E & O Mari La Bella has said that intestines from various animals are used. (He declined to specify just which animals, citing a need to protect trade secrets). In reference to the catgut story, he observed that the popular falsehood may actually have been cultivated by his company, during the firm's early days over 400 years ago in Italy, as a means of putting potential competitors off the track. No one, the reasoning was, would be eager to go into the cat killing business, associated as the animals were and are with bad luck and witchcraft. Other explanations for the catgut myth include references to the higher pitch bowed instruments sounding like cats screeching, and the fact that the gut that doctors carried in their medical kits to sew people up with was called "kit gut" -- close enough, given the vagaries of linguistic change, to catgut.

Like wire drawing, gut string manufacture is an old art, and an extensive trade in gut strings developed early throughout Europe. Southern Italy was recognized then and up until recent times as a center for high quality gut string manufacture. Gut strings are subject to considerable natural variation in quality. Early players selected their strings individually and with great care, and paid a premium price for good ones.

Our best sources of information on early gut string making are Marin Mersenne's encyclopedic **Harmonie Universelle,** first published in 1635, along with an article under the heading "Corde" in Dennis Diderot's **Encyclopedie,** 1751-65. Mersenne describes how the intestines were first soaked for a day to aid in removal of superfluous fat and such; then stretched on pegs "in the same way as the weavers who wind and twist the cord upon their nails." The fine strands were then twisted together to create strings of the desired thicknesses, after which they were polished with linen, hemp and an abrasive herb. They were then cured and later given a preservative oil. A little over a hundred years later, Diderot describes a more elaborate series of baths in the first stage, using increasingly strong alkaline solutions. He also specifies that the intestines should come from lambs 7 or 8 months old, and speaks of hair pads used in the polishing stages.

Modern gut string manufacture is in principal not much different from what it was in earlier centuries, although different contemporary sources report somewhat varying procedures. The bath in which the intestines are initially soaked may be a lye or sulphur solution, which aids in cleaning. No other chemicals are used beyond an anti-bacterial agent in the solution to prevent the evolution of unwanted new life forms in the vat. (Even still, cleaning the gut remains a foul and disagreeable procedure.) After the fibers are twisted into strings of the desired thiknesses, stretched and dried, steps are taken to reduce the dimensional irregularities that naturally occur in gut strings. This may be done by polishing them on a lathe with an abrasive, or by rolling them between metal plates. Abrasive procedures can also be used to reduce the string to a specified final diameter, although, due to the nature of gut, a very high degree of precision is not possible. Some makers apply a varnish to the finished string; the value of this is the subject of some debate.

The thickness of the final string depends upon the number of strands that are twisted together. The smallest mandolin string might comprise just two strands, while the largest bass string would use a little over a hundred.

Once again, the amount of twist given the strings is an important consideration. Increasing the amount of twist makes the string more elastic; at the same time it lowers the breaking tension point. For strings which will be tuned high, twisting can be kept to a minimum to preserve strength. If a low pitch is intended, strength is less important, but the increased elasticity is valuable in counteracting pitch distortion, so more twist can be used. By reducing the twist ratio from 6 to 2¼ (which corresponds to a tighter twist), the acceptable lower range limit for gut strings can be extended downward about an octave.

Once the gut has been twisted into strings, thicker strings can be made from thinner by twisting them together. This can be done by the end user without special equipment if desired: soak the original thinner strings for twenty minutes or so; double them by looping one or more over a nail, bringing the ends together and weighting them; give them the desired amount of twist; immobilize them there and let them dry in that form. There is testimony to the effect that the twisting does indeed seem to improve performance in mid- and lower-range gut strings.

In tone, gut strings are weak in the partials and strong in the fundamental, giving them a darker and more subdued sound than metal. Players often find them more sensitive to dynamic and timbral distinctions. In comparison to nylon, some players feel that gut fares better in the upper ranges, as in the upper registers of the lute. In the days before overwinding, gut alone was used of necessity in the bass (since metal of the required thickness would be far too rigid), but the sound admittedly was dull. Gut overwound with metal later came into use.

Some inconveniences associated with gut: Gut strings are notoriously poor for holding tunings, because they are greatly affected by changes in humidity. They are prone to natural dimensional irregularities, making for strings which don't sound "true;" i.e., which vibrate inharmonically. The material itself is not as strong as the synthetic materials (yet it is less prone to stretching and distortion under tensions short of the breaking point), and it is subject to drying out and deterioration with age. Gut strings also are not as readily commercially available these days. When they are, they can be expensive, but some of the outlets listed at the end of this article do have gut strings at very modest prices -- in some cases cheaper, in fact, than nylon.

NYLON

Nylon strings sound fairly similar to gut, and are now used almost everywhere that gut once was. Nylon is a 20th century plastic, a synthetic polymide resin created by the reaction of dicarboxylic acids with diamines. When formed into a string, it possesses both flexibility and high tensile strength. There are several varieties of nylon. For musical strings, a variety identified as nylon 611 is used, which has greater tensile strength than more widely-used forms of nylon used in textile fibers and such. Nylon stretches more than gut and takes longer to stabilize after being brought up to tension. Some nylon musical instrument strings are pre-stretched to reduce the need for repeated retuning.

Monofilament line is normally used, but some overwound strings use an aggregation of nylon thread for the core. A typical wound violin string uses about 250 strands each of about .0002" diameter; a wound cello string might use as many as 700. A nylon-like plastic has also been used as the overwinding material on some guitar strings.

SILK

Domestication and cultivation of the silkworm began in Japan around 3000 B.C. Because of its strength and suppleness, silk has long been a

standard stringing material in the east. It was at one time used in the west as well -- the Savarez company made silk strings up until 1939, and until recently there were some Italian manufacturers in that line as well. Some European folk instruments, such as the Russian chonguri, use silk. But for the most part the role of silk in the west has been reduced to occasional appearances as a core material for overwrapped strings.

To form a silk string, an aggregation of silk threads is held together by glue or by braiding or twisting. Silk strings are softer and stretchier than either gut or nylon. They are so stretchable, in fact, that a koto player can bend the string's sounding pitch downward after plucking, by pinching the string on the un-sounding side of the bridge and stretching it toward the middle, thus slackening it on the opposite side.

Like gut, silk is in the process of being superceded by nylon, even among players of kotos and other traditionally silk-strung instruments. The reasons for the shift are the strength of the material and the very high cost of silk.

ANIMAL MATERIALS (aside from gut and silk, which were discussed earlier)

What animals have hair long enough to be used for instrument strings? Humans have the capacity to grow their hair longer than most other mammals, but I have no knowledge of anyone using human hair in musical instruments.

The hair that has been used most frequently, in instruments from many parts of the world, is horsetail. Multiple strands are twisted together much like strands of gut or silk, to produce a string of the desired thickness. One of the best known of these is the Yugoslavian gusle, an instrument full of horse symbolism, with horsehair string, horsehair bow, and frequently a carved horse head at the end of the neck. Horsehair-strung instruments, particularly fiddles, but harps and zithers as well, also appear in several forms in Mongolia, Georgia, and north and central Africa. Isolated examples exist in Iran, India and Sweden. The Apache fiddle, Kizh, used horsehair strings as well.

Other animal materials: In recent years kora players have been using nylon fishing line for strings, but their traditional stringing material was leather thongs. Another leather string instrument is the Pulluvan kudam, a plucked variable tension chordophone in south India. Animal sinew is used on goras and lesibas, the extraordinary musical bows sounded by blowing, used in parts of southern Africa. Sinew is also used in the panduri, a fretted lute from Georgia. The Ainu tonkori, a five-string plucked zither, now usually played with commercially-available Shamisen strings, traditionally used deer sinew or twisted whale tendon. The central Indian bin baja is a bowed harp which uses the veins of cow or deer for strings.

VEGETABLE FIBER

At various times people have used twine and rope as stringing material, as in the old washtub bass. (So-called "rope core" strings don't fall in this category. The name refers not to the material but to the way in which fine strands of wire are woven together.) Closer to the natural state, some particularly strong vines have been used. Vegetable fiber strings will generally lack both the suppleness and the strength of gut, silk or nylon. Wild pineapple fiber is used in the belembautuyan, a gourd-resonated musical bow, sounded by striking with a stick, of Guam. The same fiber was traditionally used on the Sumatran gambus lampung, a short neck lute similar in form to an oud, but with a leather soundtable. The xizambi of Mozambique and South Africa uses a flat, ribbon-like string made from the leaf of a particular species of swamp rush. It is a mouth bow with some unusual features, which we will discuss in another connection later.

Natural vegetable fiber is also used as stringing material in idiochord zithers. An idiochord is a string instrument in which the string is not separate and attached, but is of a piece with the body of the instrument. The simplest and most common form for this is a length of bamboo or raffia stalk on which a long narrow section of stringy fiber has been lifted from the stalk at the center, but left attached near the ends. Two small bridges in the form of slivers of wood or bamboo are wedged under the lifted fibers and shoved towards the ends, in this way both raising the fiber and tightening it. The end of the cane must then be wrapped with twine or wire to prevent the raised portion from running all the way to the end and disconnecting entirely. The thin strip of fiber thus raised and tensioned functions as a string, while the hollow body of the stalk serves as a resonator.

Instruments built upon this principle exist in Africa, India, Southeast Asia and the Pacific. They may be crudely made or more refined. The Valiha, from Madagascar, which has given rise to some of the most beautiful music you will ever hear, was traditionally an idiochord zither very much along the lines described here. (The valiha has since converted to leather strings and then to metal strings often made from bicycle brake cable. It may also now employ an independent resonator). A common elaboration on the basic idiochord zither form is the raft zither, in which a row of relatively small diameter bamboo tubes are bound together. Another sophisticated realization of the instrument is the mvet of west central Africa, made of raffia with gourd resonators. It uses an unusual vertical notched bridge to hold five strings up and away from the stalk in a sort of two-dimensional pyramid pattern, producing ten pitches (five on either side of the vertical bridge). It too has in recent years moved toward the use of metal strings.

ODD AND SILLY STRINGS

As mentioned earlier, strings can be made out of just about anything. If you can accept a tiny sound output or can depend upon electric amplification to magnify a feeble tone, or if you likewise can accept larger-than-usual amounts of pitch distortion and inharmonicity, then you can have some fun with imaginative and unlikely approaches. There are two unorthodox string types that are particularly worth mentioning here.

One is coiled springs. We are all at least indirectly familiar with some of the acoustic properties of springs, because until recently electroacoustically excited stretched springs provided the most economic available source of artificial reverberation. In that capacity they were used liberally to enhance the sound of recorded and live pop music performances. More directly, most people have at one time or another sproinged a stretched spring and enjoyed the slightly comical, highly reverberant sound. Several inventive instrument builders have worked with spring strings, including Prent Rodgers, Ken Butler and others. Springs can concentrate very high mass in a short length with relatively little rigidity, with the result that they are useful for producing low pitches. Their volumes tends to be low, in part because their stretchiness prevents them from driving soundboards or other sound radiators efficiently. But, being made of steel, they work well with electromagnetic pickups, and so are easily amplified electric guitar style. Springs come in all kinds of sizes and degrees of rigidity, from very long, thin, finely coiled turntable drive belts to great massive things for industrial purposes. Their tone varies accordingly. Generally, though, the sound quality is highly inharmonic and noisy, but innately quite interesting. It is often possible to hear a distinct predominant pitch, which may or may not be the fundamental; the fundamental is often subsonic.

The other unorthodox string type that I wish to highlight here is flat, ribbon-shaped strings. Metal strapping material, magnetic recording tape, flat rubber bands and many other ribbon-like materials will behave as musical strings when stretched tautly between two points. Their shape alters vibrating behavior in that they are not uniformly free to flex in all directions. I am not aware of any studies of the acoustic behavior of ribbon strings; however, common sense as well as empirical observation suggest that they do vibrate harmonically in the direction they are free to vibrate.

The most noteworthy characteristics of ribbon strings derive from the fact that the wide flat surface gives them wind resistance that round strings lack. How much this inhibits vibration is difficult to estimate. But it has the positive effect of allowing the vibrating string to move more air by itself, without the aid of a separate soundboard. (You can verify this for yourself by stretching one of the broad ribbon-style rubber bands between two fingers and plucking it, then doing the same with one of the narrow stringy kind -- the broad one will be noticeably louder.) One noteworthy application of this principle is found in the xisambe (mentioned earlier in this article), used by the Tsonga people of south eastern Africa. It is a mouth bow, with a ribbon-shaped string stretched on a curved stick with serrations carved into it. The stick is held so that it rests against the player's chin near one end, and the ribbon-string passes through his slightly open mouth. The player uses a second, shorter stick to scrape along the serrations of the bow; this agitation excites the string, and its harmonics are resonated by altering the shape of the oral cavity. The player varies the string length by stopping it with his fingers at the far end. Without the greater air-moving capacity of the ribbon string, the subtle means of exciting the string by indirect agitation might not have sufficient effect to make the whole system work with any volume.

The reverse situation holds as well: in addition to moving more air than round strings, ribbon strings are also far more responsive to air currents. Take note, makers of aeolian harps! This quality has also been used to advantage in hummers -- small vessels or frames with attached strings that sing in the wind as the instrument is whirled on a cord. It turns out that one of the most effective stringing materials for these are the flat rubber bands.

The enhanced response of flat strings to surrounding wind currents also makes much more viable the idea of breath-activated string instruments. In the February 1986 issue of EMI was an article on the lesiba, a southern African blown-string instrument. The lesiba has a short section of flat quill comprising the last inch or two of an otherwise normal string, and it is this part that is blown to excite the string. For a purer example of the idea, consider the instruments that Hornbostel and Sachs termed "ribbon reeds." A ribbon reed is any blade of grass or similar band-shaped material stretched taut between the fingers of two hands and excited by blowing, often with the hands cupped behind to form a resonant air cavity.

WHERE TO GET WHAT

Locating strings by instrument type:

Strings for standard western instruments are widely available through retail and mail order music outlets. In most cases these strings will be either nylon or high-tensile steel wire, wound or not, as the case may be, with one of several commonly used metals.

Standardized string sets for sitar, sarod, koto, balalaika, tamboura and similarly important non-western instruments can be had from some of the outlets listed below. So can standardized strings for not-too-obscure western folk instruments, such as hardanger fiddle, classical banjo or various sizes of ukulele. Commercial versions of folk or non-western instrument strings now available are often made of nylon or steel, differing from mainstream commercial strings primarily in that the lengths and gauges are selected for the particular instrument.

Strings for more obscure instruments often are not commercially available as such. For many, there may not even have developed a standardized form for the strings. An independent sort of resourcefulness is called for in those cases, which happens to be in keeping with the spirit of the instruments anyway.

Locating strings by string type:

Rather than specifying an instrument type, one can also seek out particular kinds of strings by

specifying materials, lengths and gauges.

High tensile steel (variously called mandolin wire, harp wire, zither wire, music wire or piano wire) is available in finely graded gauges and in in coils of great length at piano supply houses (check the phone book in any large metropolitan area). They are also available from music retail outlets catering to harpists, dulcimer players, and builders of diverse instruments, including several outlets listed below.

Some of the outlets below also carry brasses, bronzes, phosphor bronze, and (more rarely) stainless steel. Some piano supply houses will have one or two alloys of brass in coils in many gauges. At least two makers in England are, or were until recently, making iron and brass harpsichord wires designed to replicate the physical properties of early musical wire. They are Malcolm Rose and the firm of Ormiston & Sons.

If you are looking for other metals, you will not readily find them sold as musical strings, and will have to look to industrial metals manufacturers and suppliers, or perhaps to a custom order from a musical string manufacturing firm.

Wound piano wire is available, generally in the form of copper wound or double wound on steel, in coils and in various gauges from piano supply houses. The standard sizes are heavy, and it is difficult to find medium or small diameter overwound wire in long coils. If short lengths are adequate, then you can usually get something close to what you want by turning to wound strings manufactured for one or another standard instrument. But if you need something longer than a tenor banjo string (which seems to be the longest narrow gauge wound string commercially available), you will find a gap. Many piano supply houses and string manufacturers offer custom string making to your specifications, and this may solve the problem. Or you may, as some have done, respond to the situation by making your own string winding machine.

Nylon musical strings are available in a wide variety of gauges designed for specific instruments. For non-standard musical purposes, where thicker, thinner, or longer nylon strings are called for, there are other sources of nylon. Fishing line and nylon threads are available in smaller diameters and in great lengths. They are made from a stronger nylon than the standard textile fiber stuff, but remain a grade below the material used for expressly for musical strings. For thicker nylon strings, try weed whacker line. It is typically about an eighth of an inch thick, and functions much like the very heavy gut bass strings used before the invention of overwinding.

Gut strings are available primarily from retailers specializing in replica instruments. Most of the sellers listed below will take custom orders in addition to providing standardized lengths and diameters.

And as for finding horsehair, coil springs, metal strapping, deer veins and whale sinew -- you're a resourceful person aren't you? You're on your own.

Following is a list of sources for diverse sorts of strings in the United States. Needless to say, it is not exhaustive.

Ali Akbar College of Music Store, 215 West End Ave., San Rafael, CA 94901; (415) 454-6264. The highly respected school for North Indian classical music has brass, bronze and phosphor-bronze wire, as well as steel music wire, in the full range of gauges (they do not carry wound strings). They also sell pre-cut sets of strings for classical instruments like sitar and sarod.

Bill Monical, 288 Richmond Terrace, Staten Island, NY 10301 specializes in replica gut strings.

Donna Curry's Music, 1780 Fort Union Drive, Santa Fe, NM 87501. Donna Curry's shop specializes in lutes and lute strings, and is the USA distributor for Pyramid Lute Strings. In addition she takes orders for gut strings for a broad variety of other instruments such as gamba, charanga, and traditionally gut-strung middle eastern instruments, as well as custom orders. Correct string tensions for lutes and other specialty instruments are calculated and sets custom designed.

E & O Mari, Inc., 256 Broadway, Newburgh, New York 12550; (914) 562-4400. This firm was originally founded in Italy in 1600. It is better known now by various other names under which it sells strings, including La Bella, Criterion, Hard Rockin' Steel, and several others. Mari continues to make gut strings; they also distribute gut in quantity to other makers who prepare the material for use on particular instruments. They also make strings from a wide variety of metals, as well as nylon. They will make custom strings to specification, and often work with institutions or individual artists in designing strings for special applications.

Elderly Instruments, 1100 N. Washington, PO Box 14210, Lansing, MI 48901; (517) 372-7890. This outlet sells strings for a wide variety of folk instruments and non-western classical instruments (examples -- bajo sexto, tiple, balalaika, oud, sitar and more). Their catalog also provides good information on the make-up of the strings they sell, especially the various makes of guitar string.

George Kelishek, Rt. 1 Box 26, Brasstown, NC 28902; (704) 837-5833. The Kelishek shop, where a wide variety of replica instruments are made, sells gut strings by gauges. They specialize in baroque and renaissance instruments, and also have steel and nylon strings designed for a wide range of folk instruments.

House of Musical Traditions, 7040 Carroll Ave., Tacoma Park, MD 20912; (301) 270-9090. This outlet has strings for a wide variety of non-western and folk instruments, such as sitar, sarod, tamboura, charango, bouzouki, balalaika, banjo-uke, hurdy gurdy, plus gut strings for period instruments from the George Kelishek shop. They can get many more on special order. Many of their strings for specific instruments are steel wire or nylon.

Lark in the Morning, PO Box 1176, Mendocino, CA 95460; (707) 964-5569. Lark in the Morning sells an amazing variety of unusual string instruments, and supplies replacement strings for most of them, including many Chinese, Japanese and Indian instruments, as well as their staple European and American folk instruments.

A great many individuals contributed to this two part article, with specific information, leads to further sources of information, and criticism of the manuscript. The author sincerely thanks these people: Professor Donald Hall, Scott Odell, H.E. Huttig, Donna Curry, Mark Bolles, Lyn Elder, Brian Godden, Bob Archigian, Walter Lipton, Bill Monical and David Eisner.

BIBLIOGRAPHY

Abbot, Djilda & Segerman, Ephraim, "Strings in the 16th and 17th Centuries," in **Galpin Society Journal** XXVII, 1974.

Bolles, Mark Emery, "Harpmaker's Notebook #10 -- Real Strings" in Folk Harp Journal #65, Summer 1989.

Bonta, Stephen, "Further Thoughts on the History of Strings," in **Catgut Acoustical Society Newsletter** #26, November 1976.

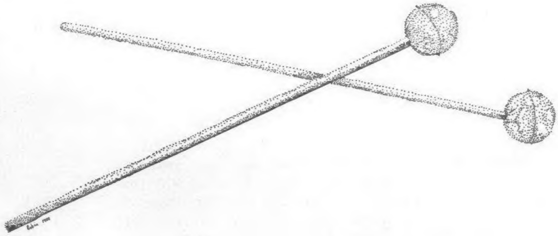
Bonta, Stephen, "Catline Strings Revisited," **Journal of the American Musical Instrument Society**, Volumue XIV, 1988.

(bibliography continued overleaf)

Davis, E.B., "A Design Guide for Steel-Bronze Musical Instrument Strings," **Catgut Acoustical Society Newsletter** #38, November 1982.
Firth, Ian, "Overwrapped Strings: Design Guide for Incorporating Limitations," **Catgut Acoustical Society Newsletter** #45, May 1986.
Firth, Ian, et al, "String Design Equations," **Catgut Acoustical Society Newsletter** #46, November 1986.
Fletcher, Neville H., "Plucked Strings - A Review," in **Catgut Acoustical Society Newsletter** #26, November 1976.
Goodway, Martha, & Odell, Jay Scott, **The Metallurgy of 17th- and 18th-Century Music Wire** (Stuyvesant, NY: Pendragon Press, 1987).
Hanson, Roger, "Analysis of Live and Dead Guitar Strings", **Journal of the Catgut Acoustical Society** #48, November 1987.
Hellwig, Friedemann, "Strings and Stringing: Contemporary Documents," in **Galpin Society Journal** XXIX, 1976.
Hubbard, Frank & Wraight, Denzil, "String", in **New Grove Dictionary of Musical Instruments**, Stanlie Sadie, ed. (London: Macmillan Press, 1984).
Huttig, H.E., "Musical Strings", in **American Lutherie** #9, Spring 1987.
Lyman, Frederick C., "Bass string Update," in **American Lutherie** #16, Winter 1988.
Mersenne, Marin, **Harmonie Universelle**, The Book of Instruments, translated by Roger E. Chapman (The Prague: Martinus Nishoff, 1957) (originally published in Paris, 1635).
Pickering, Norman C., "Physical Properties of Violin Strings," in **Journal of the Catgut Acoustical Society** Number 44, November 1985 (112 Essex Ave., Montclaire, NJ, 07042).
Pickering, Norman C., "Nonlinear Behavior in Overwound Violin Strings", in **Journal of the Catgut Acoustical Society** Vol. 1 #3 (Series II) May 1989.
Thomas, W.R. and Rhodes, J.J.K., "Harpsichords and the Art of Wire Drawing," in **Organ Year Book** XI, 1980.
Valentich, Joseph, "Strings for Ethnic Instruments," GAL Data Sheet #17 (Tacoma: the Guild of American Luthiers, 1980).

THE SUPERBALL MALLET

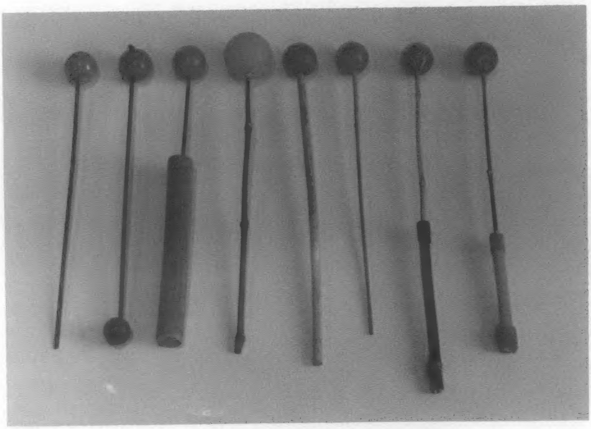
By Richard Waters



The first time I saw one was in Lee Charlton's studio in Fairfax, California. It was 1967 and the summer of love had spread out over the Bay Area. I had just started making small instruments/ sculptures and Lee and I and several others were getting together for an irregular series of sessions of experimental music that was to be known later as "New Music." Most of the players were jazz oriented but there were rock & rollers, African and Indian musicians as well. During one session a bass player, Clyde Flowers, who was a regular, whipped out a high-density rubber sphere in which had drilled a hole and to which he had fastened a ladies' flat hairpin. He was enthusiastic. "Listen to this," he said. "This thing is sympathetic to any smooth surface." With that he pulled it across his bass and smiled as it moaned and groaned. "It works like a regular mallet but it also has this friction thing that's unreal." We all agreed. Clyde took it around the room and played the drums, gongs, piano soundboard and other smooth surfaces. The sound was from another planet or the bowels of the earth. We tried it on the Waterphone which had just recently been invented. It worked especially well on the bottom diaphragm. Clyde said he had happened upon it by chance while working on some mallets to play his bass with. We were impressed and by the next session we all had superball mallets.

About a year later we put a name on the band -- "The Gravity Adjuster Expansion Band" -- and were rehearsing about once per week and gigging occasionally in the Bay Area. Shelly Mann, the Los Angeles jazz drummer, had flown up for one of our sessions to buy a Waterphone (the first one I sold). When he returned to Hollywood he did a couple of studio sessions and demonstrated the Waterphone for the percussionist Emil Richards, who does a lot of studio work in L.A. Two weeks later Emil flew up, bought a couple of Waterphones and picked up on the superball mallets. That Christmas he gave hundreds away as gifts to friends and business associates. This literally changed the sound tracks for TV and movies, as everybody wanted that other worldly sound of a superball on a gong or -- ? Any point of suspense or mystery would be highlighted with the friction potential of the superball mallet.

It was such a natural on the Waterphone that I began making them as an accessory. I graduated from hair pins to flat spring steel for the shaft. I am currently making both the shaft and the handle from bamboo, which works well. I have found that different diameter superballs create different tonal ranges on the objects they are played upon. And besides instruments, they can be used on windows, floors, walls, automobiles, etc. These high density spheres can be purchased at your local toy store. In the world of mallets they were truly a breakthrough. Thank you, Clyde Flowers!



AT LEFT, superball mallets in several sizes.
ABOVE: Stipple drawing by Robin Goodfellow

THE SOUND ARTS EXHIBIT AT VISTA FINE CRAFTS

Notes by Peter Adams
Photos by Sherrie Posternak

Sound Arts, an exhibition of musical instruments, was presented by Vista Fine Arts of Middleburg, Virginia between August 20 and September 9 of this year, showing the variety of musical instrument makers currently working in this country. This exhibition of 37 instruments (mostly string instruments) included a museum-quality reproduction of the Paris vihuela de mano made by Raphael Weisman. This instrument was the premiere piece of this well attended exhibition. A second instrument of special interest was Geoff Stelling's gold plated "Master Flower Deluxe" banjo. Other instruments of interest included several experimental instruments, including a guitar with sympathetic strings, Catherine Favre's "Magical Moon Harp", and several whimsical instruments made by Michael Creed. Of surprise was the inclusion of folk instruments, including two Finnish kanteles by Gary Upton, a set of 3 tuned gongs by Richard Selman, and an mbire dzavadzimu. Even electronic instruments were represented by a piccolo bass guitar by Jay Hargreaves.

ABOVE:
On the left, Sam Rizzetta's Butterfly Harp. To the right, two mbiras set in gourd resonators, made by Richard Selman.

AT LEFT:
Zoomorphic instruments by Michael Creed. Sad it is that we can't reproduce these things in color. On **Toucan Tango**, sounds happen when you turn the banana clockwise. The gallery owner's cat was scared of **Melody Monster**; his eyes pop up and down and a bell and clapper arrangement in his mouth sounds when he's played. **Decoy**'s tail, mouth and one claw somehow work together to produce a neat rhythm.

NOTICES

THE ONLY BOOK IN SAWING: **Scratch My Back: A Pictorial History of the Musical Saw and How to Play It**, by Jim Leonard and Janet Graebner. Features profiles of sawyers world-wide in 124 pages of fascinating information. Includes over 100 photos and illustrations, index and bibliography. U.S. Dollars $19.95, $3 shipping/handling (in CA add 6% tax). For information, contact Janet E. Graebner, Kaleidoscope Press, 1601 West MacArthur, #12F, Santa Ana, CA 92704.

POLYRHYTHMIC NEW FOLK MUSIC: Rising Tide, a new cassette tape from White Bear Enterprises, is now available. Bob Grawi on Gravikord (featured in EMI Volume III #6), with Pip Klein on flute, David Dachinger on Bassoon, and Geoffrey Gordon on Tabla. $11 from White Bear Enterprises, 247 West 16th St., New York, NY 10011. Other tapes are available too, including Gravikord demonstration tape and additional information on the Gravikord.

RATIONAL MUSIC FOR AN IRRATIONAL WORLD is the new compilation cassette tape from the Just Intonation Network, featuring 18 compositions in Just Intonation by members and friends of the network. $9.98 ($8.98 for network members) from The Just Intonation Network, 535 Stevenson St., San Francisco, CA 94103.

FOLK HARP CONFERENCE MINNESOTA takes place July 18-21, 1990, Augsburg College, Minneapolis. Sponsored by the International Society of Folk Harpers and Craftsmen. For information contact Gaylord Stauffer, PO Box 4203, St. Paul, MN 55104 (612) 724-8071.

PICTURE NOISES FROM THE GLOBAL SWAMP -- sonic documentation from the Madison intermedia Festival of the Swamps. Saxophone pyrotechnics, sound poetry, primal ranting, tense and precisive improvisation, complex drumming. $5 ppd. from Colin Hinz, 349 West St. N., Apt. #3, Orillia, Ontario, Canadada, L3V 5E1. "Successful beyond documentation"-- Photostatic Magazine.

JUST INTONATION CALCULATOR by Robert Rich. Composer's tool for JI. Internal sound for tuning reference; shows modulations; reduces fractions; converts between ratios, cents, DX7II/TX81Z units; MIDI tuning dumps. Requires Macintosh with Hypercard -- only $10.00. Soundscape Productions, Box 8891, Stanford, CA 94309.

MICROTONAL MIDI TERMINAL by Denny Genovese is a real time performance program for just intonation on virtually any MIDI controllable musical instrument; also a powerful tool for analyzing & constructing microtonal scales. System requirements: IBM PC, XT, AT or compatible with 128K, DOS, Roland MPU- 401 or compatible MIDI interface, MIDI controller and MIDI controllable musical instrument. $50. Denny's Sound & Light, PO Box 12231, Sarasota, FL 34278.

"SINGING GLASSES: The Glass Harp: Liselotte Behrendt-Willach"; Quality cassette of classical and folk tunes by Europe's leading performer on glasses ground to pitch. $8.50; $1.50 S&H: Sampler Records, PO Box 19270, Rochester, NY 14619. 800-537-2755, Visa, Mastercard. Free catalog.

MARIMBA BAR TUNING through the third harmonic; marimbas custom built and rebuilt; Helmholtz resonators made to order. MARIMBA ONE, PO Box 786, Arcata, CA 95521, phone (707) 839-5725.

EMI BACK ISSUES: Back issues of **Experimental Musical Instruments** numbered Volume V #1 and later are individually available for $3.50 apiece. Earlier issues available in volume sets of 6 issues each, photocopied and bound: Volumes I through IV, $14 per volume. Order from EMI, PO Box 784, Nicasio, CA 94946, or write for complete listing. Corresponding cassette tapes also available for each volume; see information below.

CASSETTE TAPES FROM EMI: **From the Pages of Experimental Musical Instruments**, Volumes I through IV, are available from EMI at $6 per volume for subscribers; $8.50 for non-subscribers (each volume is one cassette). Each tape contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Order from EMI, Box 784, Nicasio, CA 94946.

A REMINDER -- Unclassified ads here in EMI's notices column are free to subscribers for up to 40 words; 30 cents per word thereafter. For others they are 30 cents per word, 15 word minimum, with a 20% discount on orders of four or more insertions of the same ad.

RECENT ARTICLES, continued from page 24

Journal of the Catgut Acoustical Society Vol. 1 #4 (Series II), November 1989 (112 Essex Ave., Montclair, NJ 07042) contains the usual complement of very valuable, if highly technical, articles. Among them:

OF OLD WOOD VARNISH: PEERING INTO THE CAN OF WORMS, by C.Y. Barlow and J. Woodhouse, analyzes the varnishes on several old violins (sometimes credited with containing magical secret ingredients). Included are fascinating scanning electron microscope photographs.

PROPOSED MODEL FOR REED ACTION IN THE BASSOON, by Francoise Rocaboy, suggests that the forces controlling the opening and closing of reeds are not identical for cylindrical single reeds (clarinets) as for conical double reeds (oboe and bassoon). While both the opening and closing of the clarinet reed are dictated by reflected high and low pressure fronts within the tube, with double reeds the moment of reopening seems to determined by spring-mass factors within the reed itself.

ART BENADE AT THE INSTITUT DE RECHERCHE ET COORDINATION ACOUSTIQUE/MUSIQUE IN PARIS, by Rene Causse, presents itself as an homage to the late musical acoustician, but contains a great deal of information on research in the areas of controlled multiphonics for wind instruments and design considerations for brasswind mutes.

INTERNATIONAL SYMPOSIUM ON MUSICAL ACOUSTICS -- ABSTRACTS: these are abstracts for papers presented at ISMA 1989; quite a few (more than can be listed here) deal directly with questions relating to instrument design, and will be of interest to technically-minded builders.

RECENT ARTICLES IN OTHER PERIODICALS

The following is a selected list of articles of potential interest to EMI readers which have appeared recently in other publications.

REDISCOVERING THE VENDA GROUND-BOW by Jaco Kruger, in **Ethnomusicology** Vol. 33 #3, Fall 1989 (Morrison Hall 005, Indiana University, Bloomington, IN 47405).

A look at the construction, music, and cultural context of a traditional ground bow, now rare, of the Venda people of South Africa. It usually took the form of a string running vertically from a bent-over sapling at the top to a corrugated iron sheet or other anchorage over a hole in the ground below.

GALLERY: BEN NEILL by Julia Loktov, in **Option** #29, Nov/Dec 1989 (2345 Westwood Blvd. #2, Los Angeles, CA 90064).

Ben Neill has developed the Mutantrumpet, a glorified trumpet with three bells, extra valves including a quarter tone valve, and a slide. This article discusses Neill's instrument, musical background and some of his current projects.

PARTCH'S 'REVELATION,' ON HIS INSTRUMENTS by Allan Kozinn, in **The New York Times**, Nov 13 1989.

A review of Harry Partch's 'Revelation in the Courthouse Park' performed in November by a group of Julliard students directed by Danlee Mitchell at Alice Tully Hall in New York City.

SABIAN'S OLD-NEW TRADITION, and BLENDING TRADITION AND TECHNOLOGY AT ZILDJIAN (no authors credited) in **The Music Trades** December 1989, Volume 137 #11 (80 West St., PO Box 432, Englewood, NJ 07631).

This issue of **Music Trades** contains several short pieces on the current market for cymbals. Among them are these pieces on the two largest cymbal manufacturers, both headed by descendants of the same traditional Turkish cymbal making family. The articles include some discussion of cymbal making methods, and the pros and cons of hand hammering versus machine finishing.

NEW INSTRUMENTS: HOW TO EVALUATE THE WORK OF TODAY'S VIOLIN MAKERS by Wendy Moes in **Strings** Vol. IV #3, Nov/Dec 1989 (PO Box 767, San Anselmo, CA 94960.)

If, either by necessity or simply because we grow wiser, we abandon the credo that only old violins can be good, then we need new guidelines to make intelligent judgments. This article seeks to provide such guidelines.

HORNS by Robin Goodfellow in **Music For The Love Of It** Vol 2 #9, Oct-Nov 1989 (67 Parkside Dr., Berkeley, CA 94705-2409).

A collection of history, folklore and vignettes associated with early lip-buzzed instruments.

MUSIC TOYS AND BOXES: THE PLAY'S THE THING by Andra Samelson in **Ear** Vol 14 #9, Dec-Jan 1989-90 (131 Varick St., Rm 905, New York, NY 10013).

A short appreciative essay on the childlike aesthetic of simple sound toys. Accompanying it is a set of photographs of small sculptures identified as "Butch Morris music machines," designed by various artists. The music machines do not appear to be literal sound producers.

Also in **Ear** Vol. 14 #9: HAND CRAFTED INSTRUMENTS by Barbara Benary, with photographs by Hisao Oka -- a listing of about twenty makers or retail sources for handmade instruments.

The **Galpin Society Journal** XLII, August 1989 (38 Eastfield Rd., Western Park, Leicester LE3 6FE, England) contains nine articles, several notes and queries, and a batch of book and recording reviews, concerned primarily with historical instruments. Among them:

OLDEST ENGLISH OBOE REEDS: AN EXAMINATION OF 19 SURVIVING SAMPLES, by Geoffrey Burgess and Peter Hedrick, is a study of early double reeds and their making, about which little is known since the reed is more ephemeral than the rest of the instrument.

A UNIQUE EXPERIMENTAL CLARINET BY ADOLPHE SAX, by Beryl Kenyon de Pascual, is a report on a single surviving instrument, apparently made for experimental purposes only, on which the wood around the finger holes is carved away to eliminate the small air column created by the hole itself, as described in one of Sax's French patents.

A WIDER ROLE FOR THE FLAT TRUMPET, by Andrew Pinnock: "Flat Trumpet" refers to an English slide trumpet of the late 17th century. This article describes the construction of several instruments, and contends that the instrument was more widely used than generally thought.

THE WOODHAM-RODENBOSTEL SLIDE TRUMPET AND OTHERS, EMPLOYING THE 'CLOCK-SPRING' MECHANISM, by Peter Barton, describes a particular form of slide trumpet which employed a coil spring to return the slide to its starting point.

THE TILL FAMILY ROCK BAND, by Dr. A.M. Till, gives information on 'rock bands' -- bands playing marimba-like lithophones (instruments with sounding elements of stone) in England in the late 18th and 19th centuries -- and calls for responses from anyone knowing more about the subject. Included is a wonderful 100-year-old photograph of the author's ancestral Till Family Rock Band.

A SLIDE TUBA? by Arnold Myers provides information on and a photograph of a slide tuba made by Besson & Co., London, 1860.

A 19th CENTURY HARMON MUTE, by Clifford Bevan, provides some notes on the origins of brass mutes, and reviews an 1865 US patent for what was to become known as the harmon mute.

(continued on page 23